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Current Water Pollution Control Rules for Ohio Livestock Enterprises: Description and Economic Implications

by
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1.0 Introduction

The goal of improving and/or maintaining the physical environment is becoming increasingly important to society. Through federal, state and local legislation, action in the courts in all parts of the nation, and appeals in the communications media, the individual citizen witnesses daily the concern with the environment.

The purpose of this paper is to review some of the legislative and judicial action pertaining to the control of water pollution on Ohio livestock enterprises. Also, some of the economic implications of pollution control efforts are discussed.

The paper is organized in four sections. First, a summary is provided in order for the reader to have a profile of the paper's contents. The second section describes legislation and administrative rules at both the federal and state levels which have been directed at controlling water pollution from Ohio livestock enterprises. The third section is an economic analysis of these legal efforts, and the final section offers some implications from the analysis.

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Environmental improvement or maintenance is an unsettled and rapidly changing area. The effort in this paper is focused on a description and analysis of current rules. These rules and their economic implications are likely to change over time, and those interested in this area should watch for later developments.

2.0 Summary

Legislative acts at the federal and state levels have given agencies power to control livestock pollution. At the federal level, the Federal Water Pollution Control Act Amendments of 1972 gave powers to the U.S. Environmental Protection Agency (EPA) to control water pollution from livestock feedlot sources. At the state level, the Ohio Revised Code has provided the powers to control water pollution from agricultural sources to state agencies.

The U.S. EPA and the Ohio EPA are the agencies which issue rules concerning the control of Ohio agricultural pollution. The Federal Water Pollution Control Act Amendments of 1972 require the U.S. EPA to establish "effluent limitation guidelines" for industries classified in the "point source" category. Beef feedlots which are greater than 1000 head capacity and other types of feedlots which are equivalent to this capacity (dairy, 700 head; swine, 2,500 head; sheep, 10,000 head; etc.) have been defined as point sources. The vast majority of the nation's feedlots are less than the 1000 head animal unit capacity, and most of Ohio feedlots are not affected by the current U.S. EPA rule making.

Agricultural activities other than confined feeding operations are included in the category of "non point sources." The U.S. EPA's current role is only one of identifying and evaluating non point source waste discharges, and no effort is being made to establish guidelines to control discharges from these non point sources.

Ohio EPA is the state agency which has received the authority from the U.S. EPA to monitor the state's point source waste discharges and enforce federal rules directed at these discharges. The state agency also has authority over state laws regulating air and water pollution, solid waste disposal standards, and supervision of sewage treatment and public water supplies.

Ohio EPA has gone beyond the federal legislation and rule formulation in its efforts to control agricultural water pollution. Although environmental policies are in the process of being formulated, pollution abatement efforts will be required of a substantial number of state's feedlots. Ohio EPA's current rules require newly constructed feedlots or expanding feedlots producing more than 50 pounds of BOD per day to have pollution control plans approved by the agency (50 pounds of BOD per day is produced by feedlots with approximately 45 head of dairy; 60 head of beef; 200 head of hogs; 550 head of sheep; 1,800 head of chickens with a liquid manure system; and 9,000 head of chickens with a continuous watering system). It is likely that most existing feedlots which are not expanding will be subject to Ohio EPA water pollution control rules in the near future.

Many of the benefits derived from any present or future rule established by the U.S. EPA or Ohio EPA are difficult to measure. The first difficulty is the lack of a common unit of measure to place on benefits accruing from

environmental improvement. Benefits from pollution abatement are often described in terms of an array of technical traits of the discharge such as the amounts of biological material, nitrogen, phosphorus, and dissolved solids. The second difficulty in measuring benefits of abating pollution is that the actual damage done is determined not only by the technical traits of the pollutant but also by the environment in which the pollution occurs. The amount of precipitation, intensity of precipitation, soil type, and distance of the feedlot from a water body may influence the quantity and quality of the water pollutant which reaches the stream.

The costs of environmental protection rules center around the costs to producers and consumers of diverting resources to pollution abatement activities. Also, the differential impact of these costs on various groups must be kept in mind. Fairness dictates a consideration of not only the costs of pollution abatement but also an identification of those who bear the costs.

Estimates are made of the costs associated with a rule requiring the control of water pollution on Ohio feedlots producing more than 50 pounds biochemical oxygen demand per day. The enterprises chosen for the analysis include beef, dairy, and swine production. For Ohio beef feedlots above 60 head capacity with water pollution control problems, a rule to control runoff by 1977 requires approximately $1.4 million capital outlay or approximately $13 in capital outlay per head feedlot capacity. The average cost of producing a head of beef on feedlots requiring water pollution control would increase $2.26 per head. The differential impact on producers of

different sizes is noticeable. The additional capital outlay per head capacity and cost per head sold required to control runoff from the 100 head beef feedlot is nearly triple those for the 500-999 head feedlot.

The economic impacts of a rule to control runoff from dairy lots of greater than 45 head capacity with water pollution control problems are also estimated. The capital outlay for these firms to comply with the rule would be approximately $31.40 per head capacity and would be equal to $1.1 million for the Ohio dairy industry. Annual total costs would increase by $9.40 per head (or $.07 per cwt. of milk sold) on those lots requiring water pollution control. The economic impacts are regressive in nature with the capital outlay per head capacity and annual cost per cow declining as herd size increases.

For swine enterprises with water pollution control problems and greater than 200 head sold annually, capital outlays would increase by approximately $8.00 per head of annual sales capacity or approximately $4.8 million for the Ohio swine industry. Additional total costs would be $.93 per head sold on farms requiring the installation of pollution control facilities. Economies of size in swine production are further exaggerated by the regressive nature of the rule to control water pollution.

Most of the costs of extending water pollution control rules to all Ohio feedlots would be born by Ohio farmers. Ohio's feedlots produce a relatively small proportion of the nation's total dairy, beef and swine production; therefore, a small portion of the cost increases rising from a water pollution control rule directed only at Ohio feedlots would be passed on to consumers in the form of higher prices.

3.0 Legal Efforts to Control Water Pollution from Livestock Sources

3.1 Federal Legislation and Enforcement

Efforts to control water pollution from agircultural sources have been recognized as needed; and several federal acts have been used to control agricultural pollution over the past decade. The federal legislation used include the Water Pollution Control Act of 1965, the Refuse Act of 1899 which was used in the 1971-72 period, and the Water Pollution Control Act Amendments of 1972.

The Water Pollution Control Act Amendments of 1972 (hereafter referred to as "the Act") were passed by Congress and enacted over the President's veto. The objective of the Act was to restore and maintain the chemical, physical and biological integrity of the nation's waters through the elimination of all discharges of pollutants into navigable waters by 1985 [12].

The Act required EPA to establish "effluent limitation guidelines" to be achieved by "point" sources of waste discharge. Animal feedlots were explicitly included in the point source category and were subject to effluent limitation guidelines established by EPA.

In addition, the Act directed EPA to issue information (1) identifying and evaluating the nature and extent of "non point" source pollution and (2) processes, procedures, and methods to control pollution from these non point sources. Agricultural activities including runoff from fields and crop and forest land were included in this non point source category. Under the terms of the Act, the federal EPA has a questionable legal basis for establishing effluent limitation guidelines for non point sources and can only "identify and

evaluate" the nature and extent of non point source pollution and suggest methods and practices to control this pollution. (State legislation has enabled Ohio EPA to deal with non point sources pollution problems and is discussed later in the paper.)

3.2 Rules for Agricultural Point Sources

The National Pollution Discharge Elimination System (NPDES) is the mechanism used to achieve control of discharges from point sources including animal feedlots. All point sources must obtain a permit from EPA or a federally approved state agency such as the Ohio Environmental Protection Agency. The permit recipient is issued a compliance schedule which requires a reduction in pollutants over a specified time interval.

The effluent limitation is the maximum allowable rate of discharge from a point source. Under terms of the Act, the chemical, physical and biological characteristics of the discharge determine the level of effluent limitation. The concept is that industries (including feedlots) currently possess the technology necessary to reduce this effluent limitation to some manageable quantities. Thus, the emphasis is on identifying specific technologies to be employed by industries.

The legislation adopts a two level program of effluent limitation for point sources. The first level is identified as the "best practicable control technology currently available." This level is to be achieved by all industries by not later than July 1, 1977. The second level is some technology identified as the "best available technology economically achievable." By not later than July 1, 1983, this technology must be utilized by all existing point

sources. In addition, a technology level referred to as the "best available demonstrated control technology" must be utilized by newly constructed point sources.

3.3 EPA Implementation of Federal Water Quality Act Amendments of 1972

The Act gave EPA the difficult task of identifying these technology levels and establishing a set of rules to accomplish the policy of zero discharge of pollutants into navigable waters by 1985. The feedlot industry was only one of a list of twenty-seven industries which were considered point sources, and agriculture was only one of a group of activities identified as non point sources. Moreover, EPA was ordered to publish within one year of the Act's passage the rules for each industry in the point sources category and to issue information concerning the processes, procedures and methods to control non point source pollution.

The period between the date of the Act's passage (October, 1972) and the date of EPA final rule formulation for animal feedlots (February, 1974) was filled with controversy and debate. EPA and the Economic Research Service of the U.S. Department of Agriculture each produced studies of the economic effects of proposed effluent limitation guidelines [1] and [13]. Each concluded that the economic impact of the proposed effluent limitation guidelines would be minimal for the nation's larger feedlot. Due to economies of size in the pollution control technology used to meet the effluent limitation guidelines, economic impacts would be most severe on smaller feedlots. Thus, the potential impacts of the rules would be a slight increase in the cost of producing

beef and the price to the consumer; however, the small feedlots in the North Central and Eastern states would incur larger costs and be affected substantially more than their larger western counterparts.

Prior to these studies, EPA published proposed guidelines and proposed permit application forms indicating that all animal feedlots regardless of the number of animals or degree of pollution would be considered point sources requiring permits and pollution control [6]. This proposal made the number of potential permit applicants around 2 million and aroused widespread public criticism.

After several months of debate, EPA published new proposed regulations which required permits for feedlots with capacities equal to or greater than 1000 head of beef cattle or equivalent animal units.[1] Although arousing criticism from environmental groups, EPA maintained its position by later ruling that permit applications and effluent limitation guidelines would pertain to only those feedlots of greater than 1000 head animal equivalent capacity.

The status of the nation's smaller feedlots (those less than 1000 head animal equivalent capacity) remains uncertain with respect to effluent limitation guidelines. The U.S. EPA is now in the process of reviewing information concerning the economic impact of water pollution control rules. After this review, effluent limitations applicable to the nation's smaller feedlots are to

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[1] These equivalent animal units are 700 head for dairy; 2,500 for swine; 10,000 for sheep; 55,000 for turkeys; 5,000 for ducks; 100,000 for laying hens and broilers with continuous watering; 30,000 for laying hens with liquid manure handling systems.

be announced. (Ohio EPA has already outlined rules for smaller feedlots, and these rules are presented later.)

3.4 Summary of Effluent Limitation Guidelines for Feedlots

On February 14, 1974 the final rules concerning (a) effluent limitation guidelines for existing feedlot point sources and (b) the standards of performance for newly constructed feedlot point sources were published in the Federal Register [8].

For confined feeding operations with capacities equal to or greater than the 1000 head capacity animal equivalent, it is illegal to discharge any pollutant into the nation's waters without an NPDES permit. EPA regional offices and state agencies are authorized to require feedlots with capacities of less than 1000 head animal equivalents to apply for permits if they are a significant contributor of pollution [11, p. 60].

The NPDES permit is the mechanism used to assure compliance with the requirements of the 1972 Act and subsequent EPA rule making. Each feedlot permit recipient is issued a compliance schedule which provides for the use of the "best practicable control technology currently available" by July 1, 1977, and the use of the "best available technology economically achievable" by July 1, 1983. For facilities where construction has commenced after the date of final rule making and which has a larger capacity than the 1000 head animal equivalents, the compliance schedule would provide for the use of the "best available demonstrated control technology."

The technology level employed in terms of the "best practicable technology currently available" is the control of all process generated waste water plus the runoff from a 10-year, 24-hour rainfall event.[2] EPA recognizes that pollution discharge from a control facility may occur. This overflow is legitimate from July 1, 1977 to July 1, 1983 if the pollution control facility is constructed to control feedlot runoff from a 10-year, 24-hour rainfall event plus process generated waste water.

The technology level employed in terms of the "best available technology economically achievable" is the control of all runoff from a 25-year, 24-hour rainfall event plus all process generated waste water. Thus, after July 1, 1983 the greater than 1000 head animal equivalent capacity feedlot may have discharge pollutants only if the discharge is associated with an overflow of the appropriate control facilities.

For new sources or those feedlots constructed after February 14, 1974 the technology to be employed is the "best available demonstrated control technology" which has been interpreted as the control of a 25-year, 24-hour rainfall event plus all process generated waste water. Thus, the discharge of pollutants is allowed from newly constructed feedlots with capacity in excess of 1000 head animal equivalents when overflow from the appropriate facilities occurs.

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[2]Process generated waste water is defined as "water directly or indirectly used in the operation of a feedlot including spillage from watering systems; washing, cleaning or flushing feedlot facilities." The terms 10-year, 24-hour rainfall event and 25-year, 24-hour rainfall event mean "a rainfall event with a probable recurrence interval of once in ten years or twenty-five years" as defined by the National Weather Service. For Ohio, these rainfalls are approximately 5 inches and 6 inches, respectively.

3.5 Disputes Over EPA Implementation

The National Resources Defense Council, Inc., a New York based environmental organization, has brought suit against EPA for "unlawfully excluding certain point sources discharging pollutants from regulation under the NPDES." The suit, filed in the U.S. District Court in Washington, D. C., contends that the exclusion of feedlots of less than 1000 head animal equivalent capacity is a violation of the 1972 Water Quality Act. The National Resource Defense Council argues that EPA was not given the discretion under the Act to exclude point sources for administrative convenience [11, pp. 182-192]. The suit is currently waiting court action.

The Committee on Government Operations of the House of Representatives has also issued a report calling for the repeal of regulations which exclude feedlots of less than 1000 head animal unit capacity. It is the recommendation of the committee that effluent limitation guidelines and standards of performance should be issued for all "concentrated animal feeding operations" and not just those with 1000 or more animal units [10, p. 8].

While the outcome of these actions by the Congress and by the National Resources Defense Council (NRDC) is yet to be determined, it appears likely that the nation's smaller feedlots will find themselves subjected to water pollution control pressures in the near future. Even though the intentions of the NRDC and Congress fail, current legislation and EPA rules provide latitude for water pollution control requirements to be forced upon a number of the nation's small animal feedlots. While those feedlots less than 1000 head animal units are not generally required to obtain NPDES permits nor to conform to effluent limitation

guidelines, "significant" contributors to water pollution can be required to conform to the rules regardless of size. If NRDC and congressional intentions succeed, many small feedlots will be compelled to apply for NPDES permits as the larger feedlots are currently required to do.

3.6 Ohio Environmental Protection Agency (Ohio EPA)

The Ohio EPA came into existence on October 23, 1972 with sole authority over laws regulating air and water pollution, solid waste disposal standards, supervision of sewage treatment and public water supplies. Ohio EPA was created by state legislation and is administratively separate from the federal EPA. However, Ohio EPA has the power to administer and enforce the requirements of the federal laws including the Water Pollution Control Act Amendments of 1972. It also has the power to administer and enforce those state laws in the Ohio Revised Code dealing with the abatement of pollution and to issue regulations pertaining to control of pollution. These laws and regulations which are administered by the Ohio EPA may be more stringent than the federal laws and regulations.

The agency was charged by the state general assembly to "(A) ... put into execution a long term comprehensive plan to conserve, protect, and enhance the ... natural resources of the state; (B) prevent and abate pollution of the environment ... ; (C) administer the air, water and other natural resources of the state for the use and benefit of the people of the state ..."

To date Ohio EPA has gone beyond the NPDES permit system in its efforts to control agricultural water pollution. While the rules of Ohio EPA concerning agriculture are still being formulated, pollution abatement efforts will be required of Ohio feedlots smaller than the 1000 head capacity. The standards necessary to comply with these rules have not been specified, but it is likely that all feedlots will be required to control agricultural water pollution. Although not court tested, it is likely that the state agency has the power to enforce several regulations and laws which would include a wide scope of Ohio livestock production.

First, the Ohio Revised Code gives the Ohio EPA director discretion in modifying the terms of the NPDES system established by the federal Water Pollution Control Act of 1972. The director may issue orders prohibiting or abating discharges of wastes into waters of the state and require the construction of disposal systems [9, section 6111.03H]. This provision would appear to give EPA rather broad powers to control pollution from all feedlot runoff and solid waste disposal.

Also, the Ohio Revised Code gives the director the power to approve all industrial waste disposal facilities [9, section 6111.45]. The Ohio EPA regulations state that a "permit to install must be obtained for installation of . . . a new source treatment works intended to receive wastewater that contains . . . more than 50 pounds per day of biochemical oxygen demand . . ." [9, paragraph EP-30-03]. This regulation is outside the NPDES per-

mit system and would include a vast number of agricultural establishments. The number of head required to produce an equivalent of 50 pounds per day of BOD would be the following:

Animal	Head to Produce 50 pounds BOD/day
Dairy	45
Beef	60
Hogs	200
Sheep	550
Chickens (continuous watering system)	9,000
Chickens (liquid manure system)	1,800
Turkeys	3,300
Ducks	300

The last provision is a law pertaining to an agricultural pollution control program. "The Ohio Soil and Water Conservation Commission shall recommend to the director of natural resources a procedure for coordination of a program of agricultural pollution abatement . . ." The director of Ohio EPA may utilize the Department of Natural Resources, the Division of Soil and Waste Districts, and local soil and water conservation districts in encouraging abatement of agricultural pollution [9, paragraph 1501.20].

Thus, it appears that the Ohio EPA has the capability of controlling water pollution from livestock production on any size of operation. The director may specify how solid waste is to be stored, he may issue rules concerning the disposal of solid waste, he may extend those portions of the federal rules applying to feedlot runoff, he may demand the application

for permits from newly constructed livestock facilities, and he may elicit the assistance of the local soil and water conservation districts in helping to achieve those measures which assist in abating pollution.

Current Ohio EPA rules focus is on individuals who are building new facilities, who are expanding old facilities, who are significantly contributing to pollution, or who are in excess of the 1000 head equivalent capacity. Livestock facilities which were in operation prior to Ohio EPA rule making are not being pressed to install pollution abatement facilities unless they are significant contributors of pollution or exceed the 1000 head equivalent capacity established by federal EPA rules. For livestock operations which are expanding and produce more than 50 pounds of BOD per day, Ohio EPA is asking for water pollution control plans to be submitted by the firm. Ohio EPA will inspect the plans and issue a "plan approval" which provides the operator with EPA's consent of the method used to control water pollution. For newly constructed feedlots producing more than 50 pounds BOD per day, the agency is asking the operators to obtain a "permit to install" which provides approval of the new facilities' water pollution control system.

It is likely that water pollution control rules will be directed at all of the state's feedlots. Rules being formulated by Ohio EPA and other interested agencies would require most of the state's feedlots to control water pollution.

4.0 Analysis of the Rule to Control Water Pollution from the State's Feedlots

Since it is anticipated that Ohio EPA will require most of the state's feedlots to control water pollution, the following economic analysis is aimed at assessing this requirement. Specifically, the requirement would be that all feedlots producing more than 50 pounds of BOD per day must control feedlot runoff.

4.1 Benefits of Reducing Water Pollution from Feedlots

In assessing any rule, benefits and costs associated with the rule's adoption are weighed. An economic assessment of rules controlling water pollution is extremely difficult due to the lack of a common denominator to weigh benefits against costs. The decision maker normally would weigh the benefits and costs in terms of dollars to assess a rule. Several factors cause problems in finding a common unit of measurement to examine.

First, there is a lack of a comprehensive definition of water pollution. Degrees of potential damage possessed by pollutants are often described in terms of the amounts of biological material, nitrogen, phosphorus, and dissolved solids. Biological material determines the degree of oxygen usage due to bacterial disgestion of wastes, and a measurement of this process is the biochemical oxygen demand (BOD). Another indication of the biological material is the amount of oxidizable carbon in the waste, and the chemical oxygen demand (COD) is used as a measure. Both COD and BOD are in high concentration in feedlot waste flows.

The most common forms of nitrogen in feedlot wastes are organic, ammonia, and nitrate. Organic nitrogen breaks down into ammonia nitrogen,

and ammonia nitrogen has toxic properties and converts into nitrates. Nitrates which reach streams and/or water bodies promote the growth of algae and aquatic plants. This growth increased the oxygen demand on streams and water bodies.

Phosphorus has been directly linked to the eutrophication process of streams and water bodies. Small amounts of phosphorus increase oxygen demands. While phosphorus readily becomes fixed in the soil, phosphorus from feedlots may find its way into water bodies through soil erosion.

Dissolved solids include potassium, calcium, sodium and other inorganic salts. High levels are often found in animal waste and can increase the salinity in streams and water bodies [2]. While the potential damage of feedlot wastes is high in terms of the above four technical components, the actual pollution damage done is determined by the environment in which the feedlot operates. The amount of precipitation, intensity of precipitation, degree of soil compaction, distance from a water body, density of cattle, condition of lot surface, type of ration fed to the cattle, and size of cattle may affect the quality and quantity of runoff from the feedlot. The handling of wastes is also an important factor including frequency of spreading, area to which the manure is applied, and weather conditions during spreading. Furthermore, the size and assimilative capacity of the receiving stream of water body affects the damage caused by the runoff. The damages to society caused by a particular size feedlot may vary from a negative cost (no pollution damage and positive net value in the manure as a fertilizer) to a large positive cost similar to the damages caused by a city pouring untreated effluent into a stream.

4.2 Costs in Abating Pollution

Resources are used in abating pollution that would otherwise be devoted to other productive activities. Those involved in the decision making process must face the trade-off between committing resources to environmental improvement and to other economic activities.

The decision maker must also be concerned with the equity effects of any rule regarding pollution abatement. The incidence of costs of pollution abatement often fall on one group while benefits are received by many. Our sense of fairness dictates that the differential impact of any abatement activity be identified and considered in the decision making process.

The costs and the differential impacts of a rule to control water pollution from Ohio feedlots are estimated in this study. The feedlot enterprises included in the estimate are beef, dairy, and swine. Water pollution from other feedlot enterprises such as sheep and chickens would also be controlled under the rule, However, due to predominance of the dairy, beef and swine enterprises in Ohio, most of the costs of a water pollution control rule are included in the analysis.

The rule used in the analysis would require those feedlots producing more than 50 pounds of BOD per day to control runoff from the feedlots by 1977. Runoff control facilities would be required to control runoff from a 10-year, 24-hour rainfall event or about 5 inches of rainfall. The requirement that feedlots control runoff implies that only those firms with water pollution problems would be required to install a water pollution control technology.

Estimates made in this study are upper limit estimates to the costs of the water pollution control rule. The technology used in each of the enterprises is a system consisting of a diversion terrace, settling basin, holding pond, fencing and pump-irrigation equipment. The diversion terrace directs the flow of runoff to prevent the settling basin and holding pond from catching runoff flow other than that from the feedlot. The settling basin is used to settle out solids in the runoff, and the holding pond is used to contain the runoff until the pump irrigation system spreads it on the field. It is likely that this technology set would be the most expensive technology employed by feedlot owners in order to comply with the federal or Ohio EPA water pollution control rules. It is possible that a feedlot would be located in a topography which would enable it to make little additional investment in runoff control in order to comply with state or federal rules.

Usually, cost increases are partially passed on to consumers in the form of higher prices. As cost changes occur, firms tend to supply less of the final product forcing upward pressure on the price of the final product. Thus, full impact of increased costs are counterbalanced to some degree by the resulting price increase. For cost increases resulting from water pollution control rules directed only at Ohio producers, only a small portion of the cost increase would be passed to consumers in the form of higher prices. Prices for livestock are determined in nationwide markets and are only slightly influenced by the cost structure of Ohio livestock producers. Thus, most of the costs of rules directed only at Ohio producers would be born by these producers.

The effect of the rules on the number of animals produced on Ohio feedlots depends on (1) the number of firms exiting from livestock production as a result of the water pollution control rules and (2) the change in production in the remaining individual firms. Firms would tend to shift out of production as a result of these rules. The firms with profits near zero before the imposition of the rules would incur equity losses after the imposition of the rules and would likely exit from the industry. Firms remaining in production would tend to shift production patterns as a result of their changing cost structures. These firms might decrease production as their cost structure shifts, they might shift their input mix and become more oriented toward confinement housing, or the financial requirements of pollution control technology might slow their growth pattern. In short, the paths of adjustment to the new rules are not clear.

A recent study investigated the paths of adjustment in the beef feedlot industry to alternative water pollution control rules [3]. Through simulating over time the distribution of feedlots found in the North Central states, the study was able to trace the changes in production, income, and capital structure as a result of alternative rules. The resulting shift in production was found to be a decrease of less than one percent if the rule imposed by EPA was extended to feedlots of less than 1000 head. Thus, preliminary evidence indicated that the effect of water pollution control rules on Ohio feedlot production found that the input mix would likely change slightly as a result of these rules.

The above discussion enables a number of assumptions to be made which simplifies the analysis. These assumptions are:

1. prices of inputs and outputs do not change as a result of water pollution abatement rules,
2. the input mix of the feedlot does not change,
3. production is not substantially affected by these rules,
4. only those producers designated by EPA as having a water pollution problem would be required to install water pollution control technology. Control technology would be required of feedlots with water pollution problems producing 50 pounds BOD or more per day.

4.3 Costs of Water Pollution Control Rules to Ohio Beef, Swine, and Hog Producers

4.4 Beef

Under these simplifying assumptions, the capital outlay and total cost per head sold of controlling runoff from a 10-year, 24-hour rainfall event by 1977 would be found by aggregating the capital outlays and total cost per head sold to individual producers. The distribution of Ohio beef feedlots needing water pollution control (Table 1, column (6)) can be multiplied by the capital outlay and total cost per head sold of water pollution control for each size of feedlot (Table 2, columns (2) and (3)) arrive at the economic impact to the beef feedlot industry.

For all beef feedlots above 60 head capacity with water pollution problems, controlling runoff from a 10-year, 24-hour rainfall event requires approximately $1.4 million capital investment in control facilities or approxi-

Table 1. Distribution of Fed Beef Marketings by Size Group in Ohio (1969 and 1977 estimated) and Those Feedlots Requiring Installation of Water Pollution Control Technology

Farm Size (1)	No. of Farms 1969 (2)	No. of Head Marketed 1969 (3)	Estimated No. of Head Marketed 1977[c] (4)	Estimated % of Units Requiring Control Technology[b] (5)	Estimated No. of Head Marketed from Units with Control Technology (6) (column (5) X column (4))
(Head Capacity)	(No.)	(No.)	(No.)	(%)	(No.)
1 - 49	7241[a]	70207[a]	45400.	26	11800.
50 - 99	1597[a]	64073[a]	41400.	26	10800.
100 - 199	707[b]	95591[b]	91600.	26	24000.
200 - 499	347	106191	101700.	28	28500.
500 - 999	79	65783	63000.	29	18000.
1000 +	25	32152	30700.	47	14400.

[a]Estimates of number of farms and head fattened were made from the Census of Agriculture, 1969.

[b]Estimates are from Johnson, J. B. et. al., "Economic Impacts of Controlling Runoff Arising from Fed Beef Production Facilities," unpublished paper, E.R.S., U.S.D.A., 1973.

[c]Estimates of number of head fattened are found by extrapolating trends in beef production in Ohio. The trend line was established with the data series "Steers 500 lbs. and over, January 1." Crop Reporting Service, Ohio Agricultural Statistics, issues 1970-1974.

Table 2. Ohio Beef Feedlot Capital Outlays and Cost Per Head Sold to Control the Runoff from a 10-year, 24-hour Rainfall Event

Feedlot Size (1)	Capital Investment per Head Capacity (2)	Total Cost per Head Sold (3)
(Head Capacity)	($)	($)
100	32.33[a]	5.06[a]
100 - 199	21.00[b]	3.19[b]
200 - 499	11.60	1.84
500 - 999	8.18	1.28
1000 +	3.13	.69

[a]Forster, D. L., L. J. Connor, and J. B. Johnson, "Economic Impacts of Selected Water Pollution Control Rules on the Simulated Behavior of Michigan Beef Feedlots," Research Report, Michigan State University, 1974.

[b]Johnson, J. B., et. al., "Economic Impact of Controlling Surface Water Pollution from Fed Beef Operations," unpublished, Economic Research Service, U.S.D.A., 1973. Total cost per head sold reflects an amortization rate of 8 percent interest over a 10 year life span with an annual maintenance cost of one percent of the capital investment.

mately $13 in cpaital outlay per head feedlot capacity. The average total cost would increase $1.51 per head for all beef marketed from Ohio feedlots and $2.26 per head for those animals raised on feedlots requiring control technology.

While these costs appear minimal, the differential impact of the rule on producers of different sizes is noticeable. The additional investment outlay per head capacity and additional cost per head sold for the 100 head lot are

nearly triple those for the 500-999 head lot. The pollution control technology presents additional economies of size to the feedlot industry and further encourages shifts to larger production units.

4.5 Dairy

Using the same procedure to estimate the capital outlays and cost per head sold as was used with the beef industry, the economic impact of the rule to control runoff from a 10-year, 24-hour rainfall event can be estimated. For cow herds in excess of 45 head with water pollution control problems, controlling runoff from a 10-year, 24-hour rainfall event requires a capital outlay of $1.1 million annual total costs would increase by $9.40 per head for those animals on the feedlots in the state requiring water pollution control, or the cost or producing a hundred pounds of milk would increase by an average of $.07 for those farmers facing water pollution problems.

Again, the economic impacts are quite regressive in nature. The total cost of controlling water pollution varies from approximately $.14 per cwt. of milk produced for the 45 cow herd to approximately $.05 per cwt. of milk produced for the 100 cow herd.

Table 3. Distribution of Dairy Cows on Farms for Ohio by Size of Farm, 1969

Farm Size (1)	No. of Farms[a] 1969 (2)	No. of Cows 1969 (3)	Estimated No. of Cows 1977 (4)	Estimated % of Units Requiring Control Technology[c] (5)	Estimated No. of Head Marketed from Units with Control Technology (6) (column (5) x column (4))
(No. of Cows)	(No.)	(No.)	(No.)	(%)	(No.)
1 - 30	12997	162,797	125,000	40	50,000
30 - 50	3703	136,269	105,000	40	42,000
50 - 100	1445	89,415	69,000	40	28,000
100 - 199	175	21,063	16,000	40	6,000
200 +	9	2,300	2,000	40	1,000

[a]Estimated from Census of Agriculture, 1969.

[b]Estimates are found by extrapoluting a trend live established with the data series "milk cows and heifers that have calved, January 1," in Crop Reporting Service, Ohio Agricultural Statistics, 1970-74 issues.

[c]Estimates from Buxton, B. M. and S. J. Ziegler, "Economic Impact of Controlling Surface Water Runoff from U.S. Dairy Farms," unpublished, ERS, USDA, 1973.

Table 4. Ohio Dairy Farm Requirements to Control Runoff From a 10-year, 24-hour Storm--Estimated Capital Outlays, Cost per Head, and Percent of Units Needing Water Pollution Control

Capacity (1)	Capital Investment per Head Capacity[a] (2)	Annual Cost per Cow[a] (3)
(Head)	($)	($)
1 - 29	187	50
30 - 49	69	19
50 - 99	34	10
100 +	25	7

[a]Buxton, B. M. and S. J. Ziegler, "Economic Impact of Controlling Surface Water Runoff from U.S. Dairy Farms," unpublished paper, ERS, USDA, 1973. Annual cost per cow reflects an amortization rate of 8 percent interest over a 5 year life span with an annual maintenance cost of one percent of the capital investment.

4.6 Swine

The capital outlays and total cost per head sold in order to comply with the rule controlling the runoff from a 10-year, 24-hour rainfall event are estimated for swine enterprises with greater than 200 head sold. Capital outlays required total $4.8 million for the swine industry or an average of $8.00 per head of annual sales capacity. Additional costs would total $.85 per head sold for all Ohio hogs fattened, and they would be $.93 per head sold for hogs fattened on farms requiring the installation of pollution control systems.

In the case of hogs, the assumption of no change occurring in the input mix may be erroneous. Confinement facilities have become a standard technology in the hog industry, and runoff control rules would not affect the cost structure of these facilities. Thus, the magnitude of the capital investment and increases in the cost of production may overstate the economic impacts of the rules.

As with the dairy and beef enterprises, economies of size are further exaggerated in the swine industry by the water pollution control rule. The additional cost per head sold due to the pollution control rule is $1.38 for the 200-499 head lot compared to $.54 for the 1000 head lot.

Table 5. Distribution of Hogs and Pigs Sold by Ohio by Size of Farm, 1969

Farm Size (1)	No. of Farms[a] 1969 (2)	No. of Head Fattened[a] (3)	Estimated No. of Head Fattened 1977[b] (4)	Estimated % of Units Requiring Control Technology[c] (5)	Estimated No. of Head Marketed from Units with Control Technology (6) (column (5) x column (4))
(Head Sold)	(No.)	(No.)	(No.)	(%)	(No.)
1 - 99	13302	588,508	470,000	12	56,000
100 - 199	5398	752,036	600,000	17	102,000
200 - 499	4582	1,372,935	1,096,000	27	296,000
500 - 999	1174	782,282	624,000	31	193,000
1000 +	333	494,476	395,000	27	107,000

[a]Estimates from Census of Agriculture, 1969.

[b]Estimates are found by extrapolating a trend line established with the data series "Hogs and Pigs, December 1," from Crop Reporting Service, Ohio Agricultural Statistics, issues 1970-74.

[c]Van Arsdall, R. N., R. N. Smith, and T. A. Stucker, "Economic Impact of Controlling Surface Water Pollution from U.S. Hog Production," unpublished paper, ERS, USDA, 1973.

Table 6. Ohio Hog Farm Requirements to Control Runoff from a 10-year, 24-hour Storm--Estimated Capital Outlays, Cost per Head

Feedlot Size[a]	Capital Investment per Head Sold[a]	Total Cost per Head Sold[a]
(Head Sold)	($)	($)
1 - 99	60.95	9.31
100 - 199	19.65	2.88
200 - 499	10.60	1.38
500 - 999	6.14	.90
1000 +	4.19	.54

[a]Van Arsdall, et. al., "Economic Impact of Controlling Surface Water Pollution from U.S. Hog Production, " unpublished paper, ERS, USDA. Total cost per head sold reflects an amortization rate of 8 percent over a 5 year life span with an annual maintenance cost of one percent of the capital investment.

5.0 Implications

Extending the rule of controlling runoff from a 10-year, 24-hour storm to units producing more than 50 pounds of BOD per day would result in approximately $7.3 million in additional capital outlays to the state's producers of beef, dairy, and swine. Total costs including operating expenses and ownership costs would total approximately $1.2 million per year. For each of the animal enterprises, the effect of imposing this rule is to present further economies of size into feedlot industries.

A measure of the damage to the environment from various agricultural production processes is difficult to discover. The result is that finding a set of mechanisms to maximize the net benefits flowing from rules to abate pollution is impossible. Until a common denominator is found to weigh the benefits of lessening environmental degradation, evaluations of rules must be made by considering an array of benefits which are technical in nature. Although difficult to measure, this array of benefits can be weighed against the costs of abatement to arrive at a prescription concerning the content of pollution abatement mechanisms.

The process of weighing a multi-deminsional array of benefits against the costs of pollution abatement rules and the equity effects of these rules is exemplified in the U.S. Environmental Protection Agency's and the Ohio EPA's rule formulation and administration. There have been a series of debates between administrative, agricultural, and environmental groups concerning the costs and benefits of various rules, who would incur these costs and who would receive the benefits, and the administrative costs to assure compliance. These debates have led to a series of changes in rule formulation and severity of rule enforcement, and the framing of the rules will continue to be dynamic in nature. Decision makers in both the federal EPA and the Ohio EPA have been given power by Congress and the legislature in establishing the rules for environmental improvement. The rules devised by the agencies may be lenient or tough as may the enforcement of the rules.

The debate concerning the proper rules to establish and the proper amount of enforcement will continue. Rules and enforcement policies will change as the evidence changes as to the amount of benefits and costs and the identification of those receiving the benefits and those incurring the costs becomes more clear. The uncertainties caused by this dynamic environment tends to lead to inefficiencies in the livestock industries. Producers are reluctant to make investment decisions when threatended with the possibility that the investment may be obsolete due to changing rules. Thus, new capital investments in feedlots may be delayed and resources may be allocated to other agricultural enterprises.

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